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(54) Abstract Title
Display device

(57) A display comprises a permanently reflective layer 3 and a switchable layer 4 which may be switched between a reflective and a transmissive condition. The system is illuminated by one or more light emitters positioned behind the layers. Polarised radiation 1a from the emitters undergoes multiple reflections between the layers 3 and 4 until such time as it arrives at a position in the switchable layer 4 which has been set to the transmissive state or a gap in the reflective layer 3. Preferably the incident light is circularly polarised, the permanently reflective layer is cholesteric and the switchable layer a cholesteric liquid crystal.

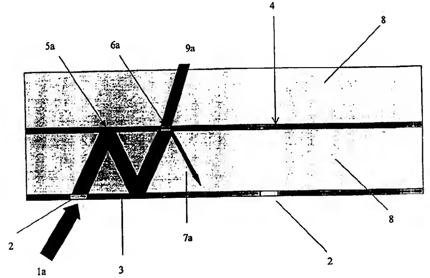


Figure 1

GB 2 364 157 A

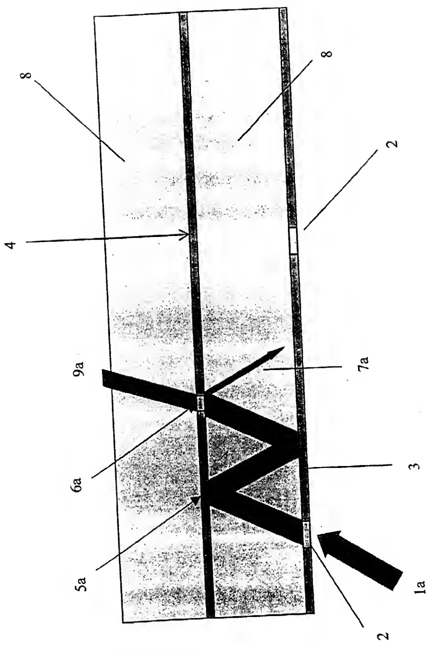


Figure 1

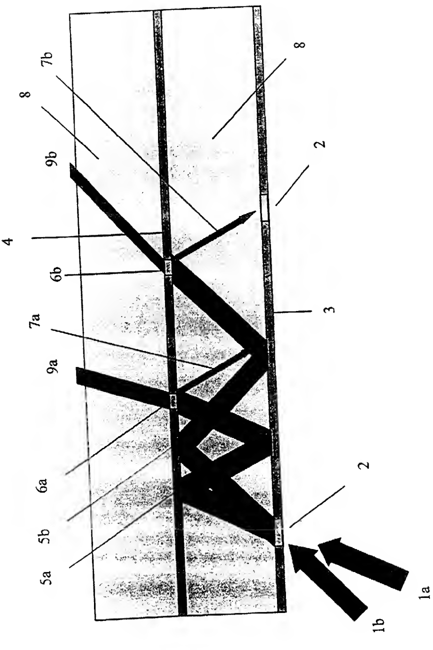


Figure 2

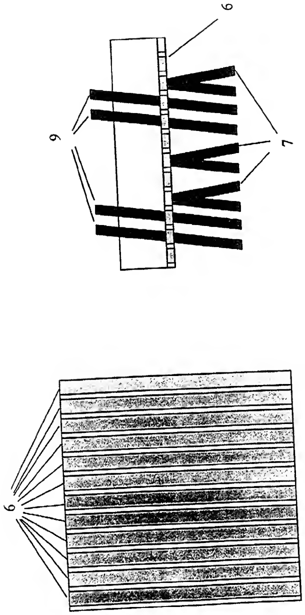


Figure 3

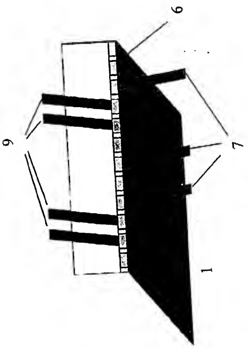


Figure 4

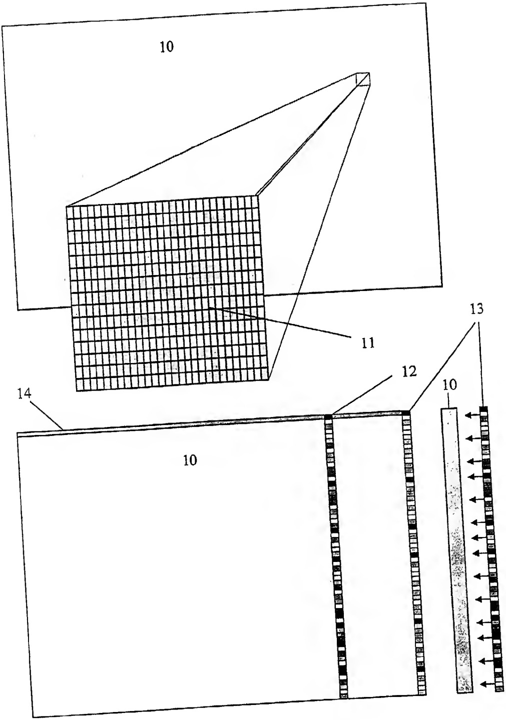
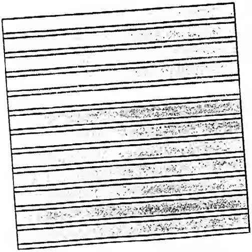
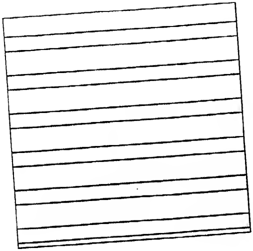


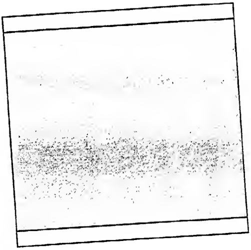
Figure 5



11a



11b



11c

Figure 6

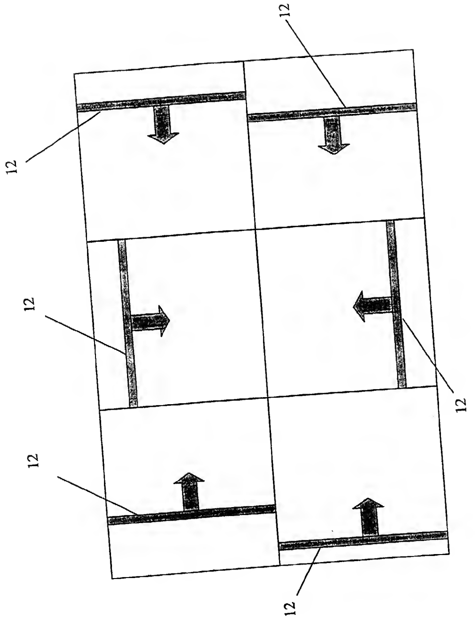


Figure 7

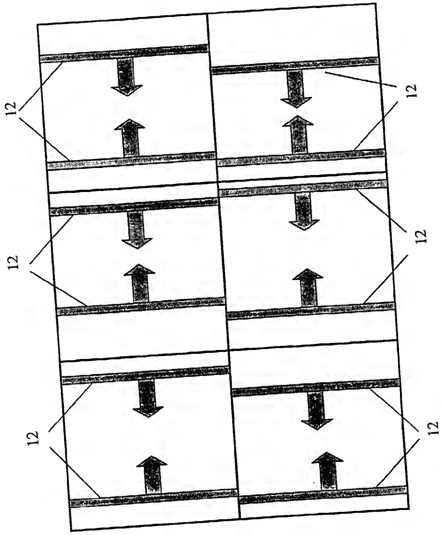


Figure 8

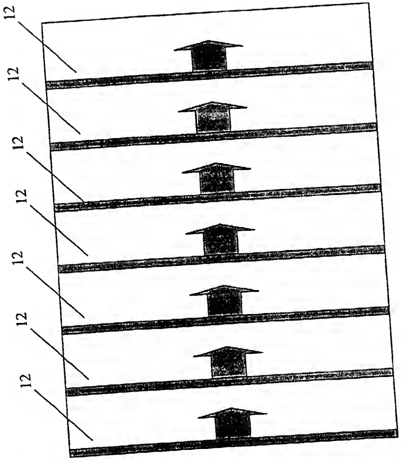


Figure 9

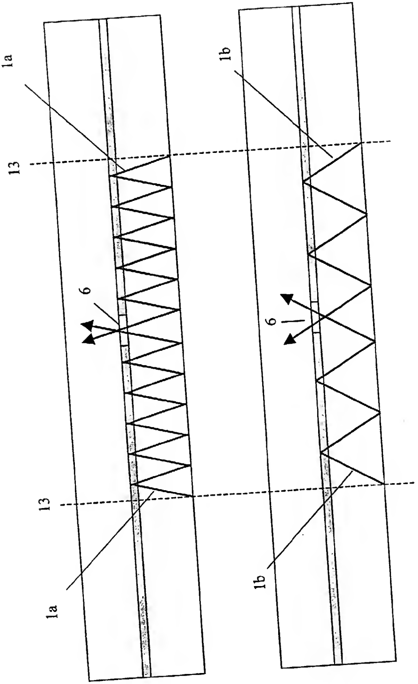


Figure 10

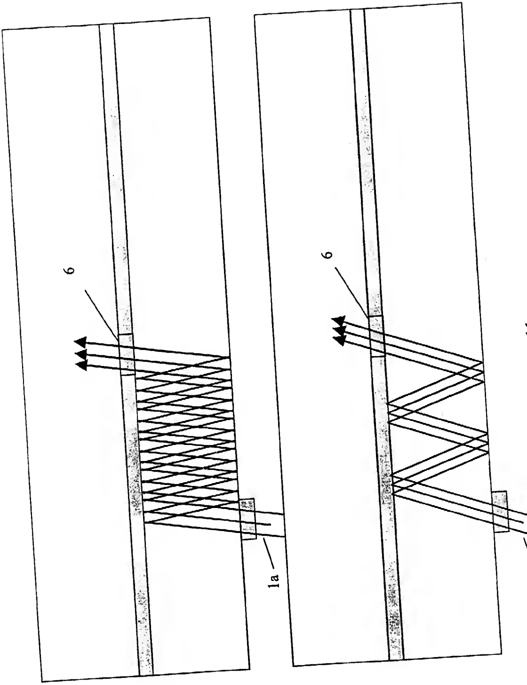


Figure 11

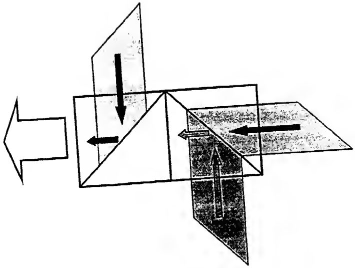


Figure 12

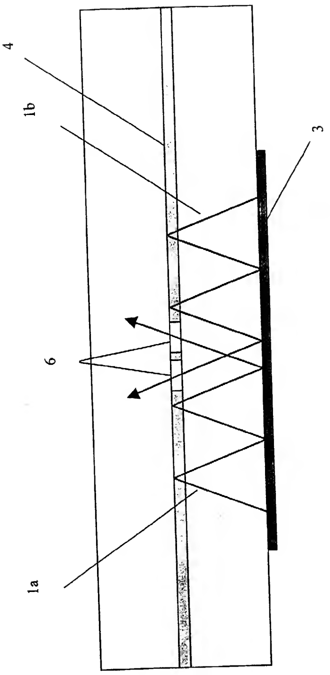


Figure 13

Background of invention

This invention provides a novel scheme for the time multiplexed addressing of a two dimensional array of localised positions in a plane, hereafter called pixels. This is a requirement for a large number of display systems and switching schemes. The main requirements of such systems are:-

a) The ability to control the optical intensity that is present at each pixel, for the complete range of the wavelengths used, in the two dimensional plane array of pixels. In this way a two dimensional distribution of intensities can, as a composite of the array of individual amplitudes and hence intensities, represent an information signal. This signal is recognised and interpreted by one or more sub-systems or receivers. In order to maximise the number of combinations of composite signals, each pixel must have a dynamic range of intensities. That is to say that the system must provide a means of varying the intensity at each pixel independently for a range of intensities.

b) That the system will provide the capabilities described above in a) above for either a monochromatic or polychromatic radiation source or sources.

c) The resolution, or minimum pixel size must be such that a very high information content is achieved for a particular two dimensional array size. This means that the pixels must be able to deliver the required range of intensities as in requirement a) for either monochromatic or polychromatic radiation in an array of small pixels. The array of pixels and the individual pixels must be such that a sufficient amount of different intensities are output in the array and that the array be of sufficient size that sufficient information is produced.

One such array is comprised of a liquid crystal which has an array of switchable transmission pixels that can modulate the intensity of radiation by changing the polarisation direction of polarised intensity with respect to the transmission axis of an analyser polariser. Alternatively, a localised excitation of an emissive material can be used, as in plasma displays where localised emission of electrons excite phosphors which emit in the red, in the green and in the blue.

Examples of problems encountered in the display systems detailed above are as follows. The former has low transmission through the system in that the most efficient form of radiation source is a diffuse white light unpolarised lamp. This means that to perform the polarisation dependent switching the radiation has to be polarised. Any radiation which is not correctly polarised is absorbed. To produce a colour composite pixel, colour filters must be placed in the path of the transmitted radiation which means that of the order of two thirds of the white light incident at any of the filters is absorbed. The latter suffers from high power consumption and addressing problems because of the need to produce large local electric fields behind the phosphors.

Resolution is a problem for both systems as the composite nature of the colour filters means that each colour pixel must contain three of the array pixels (red, green and blue) to provide a colour image. Although this is a requirement of the above systems, it is possible but not required in the present invention.

Conventional displays, particularly large area displays, and mainly because of the need to provide local control of voltages or currents at each pixel in the two dimensional array, encounter problems in providing cheap manufacturing of the panels. The advantages of the present invention are related to the separation of functions in the delivery of a range of intensities to the pixels in the array. These functions are: the switching from on to off of the pixel in the array and the determination of the intensity emanating at the individual pixels.

This is considered first for a linear array of pixels.

Essential features of the invention

In the simplest case a single radiation emitter is used to illuminate a linear array of pixels. The emitter delivers radiation between two parallel planes of reflectors (from behind one of the planes) at an angle with respect to the common normal to the planes. This results in the beam being reflected over and back between the reflectors, thereby moving along the linear array. One of the planes can be made permanently reflective but the other can be switched such that in one state it is transmissive and that this can be achieved at each of the pixels in the linear array independently. At the pixel in the array that is switched, such that the reflective/transmissive localised switchable plane is transmissive, radiation is allowed to escape. This defines the emergence of the radiation at that particular pixel. If the switchable plane is not changed to the transmissive mode at a pixel position then no radiation escapes. This defines the dark state of the pixel. For highly reflecting planes the contrast can be very high due to the unique feature that no radiation is allowed to pass when the pixel is in the off state. Any stray radiation that does not escape continues to undergo multiple reflections between the planes until it arrives at a gap in the permanently reflective plane and exits the system at this position at the opposite side of the two parallel planes without contributing to the output array of intensities. Each pixel, or a part of each pixel, can have the switchable reflective/trasmissive plane locally switched from reflective mode to transmissive mode independently. The exitance intensity can be controlled by controlling the emission intensity of the emitter and/or by varying the length of time the emitter is emitting. The quantity of radiation delivered to each pixel position is subject to the transmission of the system up to the position in question. This will be a function of the following: the reflectivity of each plane, the number of such reflections undergone to arrive at a particular pixel, the transmission of the space or material between each plane, the transmission of the switchable plane in its transmissive mode, the emission of the emitter, the efficiency of the conversion of the radiation from the emitter into a particular polarisation (if any) and the relative area of the

pixel which is switched from reflective mode to transmissive mode in the reflective/transmissive plane.

The resolution of the switchable plane can be made higher than the resolution in terms of the number of pixels. That is to say, each pixel can be divided into smaller regions each with independent switching capabilities. In this way a further control of the radiation exiting at each pixel is afforded. Non-uniform transmission across a line of pixels is also possible by varying the area of each pixel which can be addressed/switched. For example, a pixel near the emitter can have a smaller switchable area compared to the pixel furthest from the emitters. This can be used, for example, to help match the overall transmission/exitance across the linear array.

The response of the switchable plane may be dependant on the angle of incidence. If an acceptable range of angles exists then more than one angle may be input into the system. Several angles may be input at once if the geometry of the reflections allows different pixels to be addressed.

Because of the feature of the invention that the intensity of the radiation arriving at the pixel is independent for the pixels, a gain in the overall power efficiency is inherent in the system compared to a variable transmission display.

This can now be extended to a two-dimensional array of pixels which are illuminated by a line of emitters which are used to supply radiation each to their own linear array of pixels, thereby producing a matrix of positions where radiation can be supplied independently. The contrast ratio of any system facilitating the delivery of the radiation to an array of pixels is limited by the difference between the highest intensity delivered and the lowest delivered. Ideally, this is maximised by having a zero intensity dark state (minimum intensity at pixel). It may be possible to achieve this in the current invention by not emitting any radiation from the emitter.

Because the reflective properties of both the permanent and switchable reflective layers are symmetric about the normals to the planes it is possible to extend the system to the other orientation in the planes. That is to say a line of emitters can be positioned perpendicular to the first direction considered and the switchable layer can be switched using the direction perpendicular to the emitters as before. This makes the system easier to be used to form large area displays.

More than one colour can be combined to form a polychromatic beam which will behave identically to a monochromatic beam in terms of the multiple reflections. This has consequences in terms of the resolution achievable in that separate red, green and blue regions are not required at the output plane of the two dimensional array if a full colour arrayed output is required. This gives an immediate increase in the resolution achievable. The CP and the CLC must both have high reflectivities for the particular polarisation used for each of the wavelengths used that effect the image produced by the two dimensional array.

Particular examples

This document describes a scanning system for the illumination of a flat panel using one or a series of pixelated line sources. It could be used, for example, in 2D or 3D display configurations. It consists of a cholesteric liquid crystal (CLC) layer between two sheets of highly transmissive glass. Laminated to one of the sheets is a solid state permanent cholesteric polariser (CP). The liquid crystal (LC) is such a cholesteric and is aligned in the cell such that it behaves in the same way as the polariser in one configuration and as a transmitting layer in the other. That is to say, in one state, hereafter called the off state, the CLC reflects one circular polarisation of incident radiation in such a way as to maintain its polarisation and in the other transmits the radiation. In this way a beam incident at a slight angle to the normal of the CLC layer in the correct circular polarisation, and through a gap in the CP layer, will be reflected as that polarisation. If it then impinges on the CP it will be reflected with the same polarisation back towards the CLC. In this way it will undergo multiple reflections between the two reflective layers. In the other state, hereafter called the on state, the CLC transmits the circular polarisation of incident radiation such that it can contribute to the image.

The input illumination is circularly polarised in such a way as to be thus reflected at the CLC and the CP. A red, green and blue (RGB) pixelated linear illumination, for example, can be input from behind the device through a gap in the CP layer such that the light impinges on the CLC in such a way that if the area of contact has been switched, then the light passes through the CLC layer (on state for that position). If it has not been switched, then the light is reflected back with the same polarisation (off state for that position), to

arrive at the CP from where it is reflected back to the CLC layer. This continues until the light arrives at a switched portion of the CLC or another gap in the CP layer.

In the case of a three dimensional display, vertical lines of the display (which represent particulars views from particular vertical lines of pixels) are addressed individually. The light which is at first trapped between the two layers is thereby allowed to escape through the associated strip of switched CLC. This system is possible because of the unique feature of cholesteric reflection which enables right-handedly circularly polarised light (or left-handedly circularly polarised light) to be reflected as right-handedly circularly polarised light (or left-handedly circularly polarised light).

For a two dimensional display, when a particular strip of the 2D display is addressed, the light which is trapped between the two layers is allowed to escape by switching the associated strip of CLC. For the 2D display the resolution required is less than that required for the 3D displays as all views are equivalent for a particular frame. This means that the projection of the individual views associated with the 3D image case can be made redundant by switching all the views with the same intensity. This gives a display capable of 2D and 3D image production. Alternatively, a dedicated resolution for two dimensional displays can be used.

Brief description of the drawings

Figure one: Showing how a single source 1a can be used to address pixels one at a time. The resolution of the input illumination can be less than the pixel view resolution by masking the glass plate at output. The non-transmitted light will exit through the next back plane input aperture in the system 2 as it will arrive there after a fixed number of reflections.

Figure two: Showing how more than one angle 1a and 1b can be used to deliver radiation into the light pipe 8. The radiation beams undergo multiple reflections until they reach transmissive positions in the output plane 6a and 6b.

Figure three: Showing a close up plan and side view of a possible configuration for single position in an array. Areas on the position area 6 can locally be switched thereby selecting some of the beams arriving at the switchable plane for transmission 9 and some for reflection 7.

Figure four: Showing an identical configuration of switchable plane as in figure three but now only one large beam 1 arrives at the switchable areas 6. Again some areas allow the radiation to be transmitted 9 and the rest reflected 7.

Figure five: Showing a two dimensional panel 10 which has been divided into smaller areas which can be independently switched between transmissive and reflective states at the output plane. A linear array of emitters 13 is placed behind the panel and used to address the two dimensional array by addressing lines of pixels 12 individually. Each emission source delivers radiation to a separate row of pixels, e.g. the uppermost emission source in the figure is used to address the uppermost row of positions in the panel 14.

Figure six: Showing a single output pixel position and how the resolution of the entire two dimensional array and the control possible on the exitance of the system can be made dependent on the form of the sub-pixel switching areas. 11a shows a high density multiple sub-pixel switchable configuration. 11b shows the same dimension switchable sub-pixel areas but less of then in the same size pixel. 11c shows the simplest case of one large area.

Figure seven: Showing a means by which more than one panel can be tiled together to form a large area display. In this case the line of emitters used to illuminate the display panels are situated around the edge of the large area display.
Figure eight: Shows how another means of tiling several panels can be used. Because the lines of emitters are situated behind the panels they can be illuminated from different directions.
Figure nine: Shows how several lines of emitters can be used behind a single panel. Again the radiation sources are not visible unless a particular line is illuminated for a line of the CLC which has been switched to the transmissive state. This use of multiple lines of emitters reduces the refresh rate of the panel.
Figure ten: Showing how different angles can be input from either side of a panel. This can be used to reduce the refresh rate of the panel.
Figure eleven: Showing how more than one emitter can be used to illuminate a single pixel. Again different angles can be used to input the beams of radiation such that they emerge at the same pixel.
Figure twelve: Shows a simple scheme to provide polarised radiation from three different sources such that they are coincident and can be input into the system together. This is a means of providing a mixture of colours or of increasing the dynamic range of a monochromatic input position (i.e. using three emitters of the same wavelength allows a larger range of intensities to be chosen).
Figure thirteen: Showing how more than one pixel can be illuminated at the same time without a loss of resolution.

Detailed description of the drawings

Figure one shows the principle of the separation of functions at the centre of the invention. A well defined collimated beam of radiation 1 is input into a light pipe 3 which is defined by two plane reflectors 3 and 4. At least one of the reflectors 4 is switchable. That is to say that it can be converted from being reflective to being transmissive by the application of an electronic signal for example. The other reflector can be permanently reflective 3 or can be switchable in the same manner as 4 and is positioned closest to the radiation source. An access position 2 exists in layer 3 such that the radiation can be

directed through a transmissive gap in the layer either a switched position in 3 or a physical gap in the permanent reflector 3. Radiation which passes through the gap 2 arrives at a well defined position 5 in the second layer 4. This can represent the first output position. If the second layer is switched at this position 5 to the transmissive state then the radiation exits the system. If the second layer is in the reflective mode then the radiation is reflected back towards the first layer and undergoes another reflection which re-directs it again towards the second layer. The system continues to deliver the radiation along the light-pipe until it arrives at a switched position 6 in layer 4. In the diagram this is shown as 6. The dimensions of the switched area of 4 determines the fraction of the radiation 9 which exits the system. That fraction 7 which has not been transmitted through 4 is reflected as before and continues to be translated along the light-pipe until it arrives at another gap 2 in layer 3. The light-pipe can be a solid 8 which has high transmission properties and is used to confine the switchable layer 4.

Figure two shows a further example of the invention where now two different beams 1a and 1b are input into the light-pipe, but at different angles. This means that they arrive at layer 4 at a different position from beam 1a. 1a arrives at 5a but 1b arrives at 5b. Examples of the two beams exiting the system are shown at 9a and 9b. Note that the beams will exit with different angles. In this way different positions along the light-pipe can be addressed simultaneously by simultaneous input into the system. Note also that it is required that the fractions of radiation which have not been allowed out of the system 7a and 7b at the output positions 6a and 6b must exit the system through a gap in the reflective layer 3.

Figure three shows how the resolution of the output positions 6 can be made to be very high. For localised exiting positions of the system at each of the switched positions 6 there is a related radiation intensity 9. The radiation arriving at the non-switched positions is totally reflected and continues along the light-pipe. Note that this diagram is showing a number of individual beams which are arriving at the switching positions 6 independently of one and other, for example by being input into the system at different times.

Figure four shows how the high resolution of switching positions 6 can be used to further control the exitance of the system. If the output resolution of switching positions 6 is

higher than the resolution of the input beam 1 then the fraction of the radiation transmitted can be controlled by only switching some of the positions 6 to produce output 9 while reflecting the rest 7 which continues along the light-pipe until it leaves the system without contributing to the output of the system as before.

Figure five shows a two dimensional array 10 of output points or pixels of which a section of the array has been magnified 11 to show the detail. Note that these pixels represent either well defined areas defined by black lines or simply areas at which radiation arrives. The black lines are included in the diagram for reasons of clarity. The pixels are arranged in vertical lines hereafter called columns 12 to illustrate the positioning of the linear array of radiation emitters 13 which reside behind the entire array or panel. A number of such columns form the two dimensional array. Each emitter in the vertical array of emitters can supply radiation at a range of intensities across a horizontal line of pixels 14 hereafter called rows. In this way each emitter contributes to the intensity of a plurality of pixel positions across a row and a linear array of such emitters 13, each emitter contributing to its own row, can form a two dimensional array by illuminating one column at a time across the panel. Notice that the emitters 13 are positioned behind the panel 10 and can not contribute to the array of intensities except by passing radiation through the system.

Figure six shows the flexibility of the system at the manufacturing stage. The same area of a panel is depicted but each has a different resolution associated with it. The first example 11a has a high density of narrow strips across the region to depict the switching resolution of the panel. The second 11b has the same dimension of strip repeated across the region with greater spacing. The third 11c shows one large strip which covers most of the region. For an electronically addressed liquid crystal switching system these strips represent those positions at which radiation can be output from the system with a range of intensities. This ability to vary the form of the pixel width by varying the minimum region of the switchable reflective/transmissive layer has great flexibility in the radiation delivery system.

Figure 7 shows an example of the formation of a radiation delivery system which uses more than one panel and more than one line of emitters. Each panel in the tiled array of panels has its own line (or lines) of emitters 12 which produce an output which can be

scanned across the panel. Each panel contribute a fraction of the entire signal proportional to the area of the panel. The direction across which the column of intensity are scanned need not always be the same. In the figure there are four panels which are scanned horizontally and two which are scanned vertically. The arrows illustrate the direction of the scanned signals.

Figure eight shows how more than one linear array of emitters can be used in panel and how these panels may also be placed together to form a larger panel. Lines of emitters can be used to scan intensities across the individual panels in opposite directions.

Figure nine shows how several lines of emitters can be use to illuminate a single panel. Each line of emitters has a number of columns which it must address 12. Associated with each line of emitters is a gap in the permanent reflector such that any radiation not emitted from the front of the panel escapes out through the gap associated with the next line of emitters. This configuration allows very high delivery rate of the entire output signal across the panel.

Figure ten shows the means by which two different directions can be used to address the same pixel in the array but using radiation arriving from different directions 1a. The radiation beams are resolvable because of their opposing angular directions. Each starts from the position of a line of emitters 13 and arrives at the same pixel 6. If each was allowed to traverse the entire distance between the lines of emitters 13 they would have arrived at identical positions at the switchable reflector layer. In this case the symmetric case of the pixel halfway between them is shown but any pixel position between the emitters 13 can be addressed in this way by both radiation beams.

Figure eleven shows two examples of multiple beams being input into the system 1a and 1b. In each case the beams arrive at the switchable reflective layer together. The beams labeled 1a have a higher resolution than those of 1b. In each example the beams are spatially resolvable as they exit the system at different positions within the output pixel 6.

Figure twelve shows how the same input angle can be used to address different pixels simultaneously. 1a and 1b represent two beams which arrive at the switchable reflective layer in such a way as never to impinge upon the layer at the same position. Two output pixels are shown 6. The reflections are such that each arrives at every second pixel. In

this way two beams can be used simultaneously to address adjacent pixels in the linear array of pixels.

Figure twelve gives an example of a possible scheme which could be used to combine three different radiation sources into one beam in such a way as to produce a polarised beam. Combining the beams in the beam-splitter combination give linearly polarised radiation which can then be converted to circularly polarised radiation before being injected into the system.

Figure thirteen gives an example of how two beams can be used simultaneously, 1a and 1b, to illuminate two separate pixels. In the example, the two beams 1a and 1b arrive at the switchable layer 4 with equal periods of reflection but never arrive at the same pixel position along the array. The output pixel positions (where the switchable layer 4 has been switched to the transmissive state) are adjacent 6. In this case each beam arrives at every second such position while it traverses the system via multiple reflections. This is an example of a method for allowing more than one emitter to be used at once for an a single linear array and thus enables a slower refresh rate for the display.

Embodiment one

Here is described a scanning system for the illumination of a flat panel using one or a series of pixelated line sources for use in a 2D display configuration. It consists of a cholesteric liquid crystal (CLC) layer between two sheets of highly transmissive glass. Laminated to one of the sheets is a solid state permanent cholesteric polariser (CP). The liquid crystal (LC) is such a cholesteric that is switchable between at least two configurations by the application of a voltage and is aligned in the cell such that it behaves in the same way as the polariser in one configuration and as a transmitting layer in the other. That is to say, in one state, hereafter called the off state, the CLC reflects one circular polarisation of incident radiation in such a way as to maintain its polarisation and in the other transmits the radiation. In this way a beam incident at a slight angle to the normal of the CLC layer in the correct circular polarisation, and through a gap in the CP layer, will be reflected as that polarisation. If it then impinges on the CP it will be reflected with the same polarisation back towards the CLC. In this way it will undergo multiple reflections between the two reflective layers. In the other state, hereafter called

the on state, the CLC transmits the circular polarisation of incident radiation such that it can contribute to the image.

The input illumination is circularly polarised in such a way as to be thus reflected at the CLC and the CP. A red, green and blue (RGB) pixelated linear illumination, for example, can be input from behind the device through a gap in the CP layer such that the light impinges on the CLC in such a way that if the area of contact has been switched, then the light passes through the CLC layer (on state for that position). If it has not been switched, then the light is reflected back with the same polarisation (off state for that position), to arrive at the CP from where it is reflected back to the CLC layer. This continues until the light arrives at a switched portion of the CLC or another gap in the CP layer.

For the application of the invention as a means to produce a two dimensional image for a two dimensional display, when a particular strip of the 2D display is addressed, the light which is trapped between the two layers is allowed to escape by switching the associated strip of CLC. For the 2D display the resolution required is such that all views are equivalent for a particular frame or image.

The device thereby provides and allows a simple means of addressing of individual lines of a pixelated plane can be scanned across the plane (or sections of the plane) thus removing the need for a very high resolution TFT matrix or a mechanical scanning system to control the intensity arriving at particular positions in the plane, hereafter called pixels. It also allows the plane to be divided into regions by providing several lines of discrete emitters, each of which delivers the radiation to different sets of pixels.

This invention provides a novel means of addressing the lines of a display. The scheme is such that high intensity output can be achieved using a single line of emitters to illuminate different line of the screen. The intensities for the individual pixels in a line of the display are controlled by varying the output of the associated emitters. The on/off state of each line is controlled by the liquid crystal. This separation of these two functions makes multiplexing the signal easier while providing a very efficient use of the radiation source. In its most basic form very few components are required. These are, for example: cholesteric polariser, cholesteric liquid crystal cell with highly transmissive cell walls, passive addressing lines of indium tin oxide, a line of discrete emission sources, a black mask matrix to define the high resolution pixels and drive electronics for the emitters.

The cholesteric liquid crystal needs only two states (total transmission or total reflection) as the intensity at each output position can be controlled by addressing the line of emitters. Addressing of the device is simplified as each vertical line of pixels is addressed individually. The brightness of each view in each pixel is a simple function of each of the emitters at input. The overall brightness is a multiple of the brightness of the individual lines of emitters as each emitter contributes light to more than one view or pixel individually (separated by a time less than that of the resolution of the eye).

The system allows for the existence of several addressing lines across the display or for the addressing from both sides of the display or from both sides of a section of the display. This relaxes the speed required for switching of the CLC.

The system allows very high resolution to be achieved.

Each view emits at the brightness of the emitters (after transmission losses) which means a very bright display. As an example, consider RGB emitters which have a combined irradiance of 50 candela. For a display having 800 × 600 pixels and a transmission through the system of only 50%, this represents a white state of 25 × 800 × 600 candelas.

Embodiment two

Here is described a scanning system for the illumination of a flat panel using one or a series of pixelated line sources for use in a 3D display configuration. In a three dimensional display the number of switchable positions in the viewable array of pixels must exceed that of an equivalent two dimensional display. This is because each 3D pixel contains within it more than one view. That is to say the 3D display can encompass a number of pixel positions which are used to produce one 3D pixel position. In this case the required resolution in the array of switchable lines across the CLC is higher than that of a 2D display of the same screen resolution.

Addressing of the lines of pixel positions is the same as in embodiment one except that the rate at which signals are sent from the emitters and the rate at which the CLC is switched may be faster. Alternatively more lines of emitters can be used over shorter distances. A converging or diverging lens system can be placed over each 3D pixel (which contains a number of switchable positions) and this can then be used to form

different views of the pixel because different pixel positions behind the lens function will be emitted to the viewer at different angles with respect to the normal to the screen. Note that a display as described in this embodiment that is capable producing three dimensional images is also capable of showing purely 2D images by emitting identical intensities at each pixel position within each 3d pixel.

Embodiment three

In a third configuration, more than one panel of switchable lines which are illuminated by lines of emitters, as in embodiments one and two, can be placed side by side so as to form a large display whose area is the sum of the areas of the individual panels. This is referred to as tiling of the panels as described in figures seven and eight.

CLAIMS

1. A display device comprising at least one radiation emitter, whose emission intensity can be controlled, that can be used to deliver radiation to a linear array of pixels by reflection between two reflective surfaces where at least one of the reflective surfaces can be put into more than one transmission state at each pixel by reduction of the reflectivity, thereby allowing radiation to escape at each of the pixels individually in sequence.
2. A display device that comprises many linear arrays of pixels as described in claim one such that a two dimensional array of transmission positions is defined and over which the radiation exitance is controlled at each pixel position in the array such that information can be displayed.
3. An array of pixels, as described in claims one and two, where the radiation exitance can be controlled by varying the transmission at each pixel such that for a given intensity of radiation arriving at the pixel a range of intensities can be allowed to escape subject to the transmittance chosen for the pixel and such that the remainder of the radiation is reflected.
4. A display device as described in claims one to three whereby a two dimensional array with information content is produced by timing the emission of the emitters and timing the reflectivity of the pixel positions such that a complete image is seen by the observer.
5. A display device as described in claims one to four where the pixelated switchable reflective/transmissive surface is controlled by the application of an electrical signal or signals that may or may not be time multiplexed..

6. The intensity of the transmitted light that leaves the waveguide is a function of the initial source power, the efficiency of the reflective surfaces to reflect the light at each occurance of reflection along the waveguide and the efficiency of the transmission of the light through the selected pixel position where the light beam is allowed to leave the waveguide.

7. The light beams can have a particular colour of light and can be modulated independantly at their source.

8. The light beams in any of the claims one to seven may have a particular state of polarisation.

9. In the case where the light beams are circularly polarised or made to be circularly polarised, the permanently reflective layer should be a cholesteric reflector that reflects the light with the same polarisation state of light as the incident beam and that the switchable reflecting surface should be a cholesteric device, such as a cholesteric liquid crystal, that is locally switchable between reflecting a circularly polarised state to transmitting that polarised state either at each pixel independently or along lines of such pixels simultaneously where the line of pixels is perpendicular to the direction of the radiation as it progresses along an array as described in claim one.

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Application No: GB 0002918.1
Claims searched: 1 to 8

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Examiner: Geoffrey Pitchman
Date of search: 25 October 2001

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.S): G5C (CHA CHX)

Int Cl (Ed.7): G02F1/13357 G09F 9/00 9/30 9/35

Other: ONLINE: EPODOC WPI JAPIO

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
X	GB 2351834 A	(NEC)-see figure 4 and page 7 line 5 to page 8 line 20	1
A	GB 2314167 A	(SHARP)	
X	GB 2268304 A	(MOTOROLA)-see page 4 line 30 to page 5 line 5 and figure 1	1
X	WO 95/20180 A1	(FERGASAN)-see abstract and figure 5B	1, 8

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